

## OTHER

### **46) TITLE: Light-duty Gasoline Particulate Matter: Characterization of High Emitters and Valuation of Repairs for Emission Reductions**

**PROBLEM:** In 2005, the statewide on-road motor vehicle inventory estimates that light-duty gasoline vehicles (LDGVs) account for as large a PM<sub>10</sub> contribution (~40 percent) as heavy-duty trucks (~45 percent). However, the LDGV PM emissions inventory has been characterized using a much smaller database than LDGV gaseous emissions. Little emissions data exists for late model gasoline vehicles (ultra low emission vehicles and later). However, there is reason to suspect that the implementation of the low emission vehicle (LEV) programs has yielded improvements in vehicle durability and, hence, a corresponding reduction in high PM emitters.

**PREVIOUS WORK:** To develop the existing LDGV PM emission inventory, the ARB has funded previous research. In addition, studies by Southwest Research Institute and the National Cooperative Highway Research Program were used as data sources for determining emission factors for the inventory. From these sources, a cutpoint between normal and high PM emitters was determined for use in the inventory. In addition, LDGV PM emissions have been investigated for toxicity. It is the case that research evidence suggests that gasoline PM may be implicated in some adverse health endpoint responses. A fundamental issue is that PM emission factors that have been obtained under these toxicity studies have not been considered in the context of the inventory. In addition, the reasons for the high PM emissions have not been evaluated systematically.

**OBJECTIVE:** The objective of this project is two-fold. First, it includes the determination of the characteristics of the high PM emitter. Then, for the nominal high emitters, the viability, cost-effectiveness, and potential benefits of professional repairs for emission reductions will be investigated.

**DESCRIPTION:** The proposed project is intended to generate additional LDGV PM emission factors that may complement the inventory. The project includes the determination of the characteristics (e.g., population, vehicle miles traveled, emission factors) of the high PM emitter in relation to the California LDGV in-use fleet. The project would conduct emissions tests on a representative set of vehicles to compare PM and volatile organic compound emissions from both black smokers (e.g., vehicles out of tune or with broken components) and blue smokers (e.g., oil burners with worn out components). The project will define criteria for identification of high PM emitters and will determine a nominal profile(s) for the high PM emitting vehicle(s). Finally, the project will investigate the potential for professional repairs to yield reductions in PM emissions from the high emitter.

**BENEFITS:** A key issue facing ARB is a better understanding of the role that motor vehicles play in the total burden of ambient PM. LDGVs represent the most ubiquitous combustion source in California and their PM emissions have changed significantly over the past 25 years. Because of evolving tailpipe emission profiles, along with the wide variability of emissions between vehicles of the same class, additional information on emission-source profiles for the major contributors of motor vehicle PM emissions are needed.

#### **47) TITLE: Characterization of Versatile Aerosol Concentration Enrichment System (VACES)**

**PROBLEM:** VACES is a critical component of current ARB-funded research to determine how particulate matter (PM) causes adverse health effects. By providing increased concentrations of particles from ambient air, VACES enables real-time animal exposure studies. However, VACES uses water-condensation technology, which may generate artifacts in the concentrated aerosol. The ACES Project Plan from the Health Effects Institute recently stated that particle concentrators "would change the characteristics of the exhaust and/or the particles".

**PREVIOUS WORK:** The VACES developer, Professor Sioutas of the University of Southern California (USC), has co-authored papers that give reassuring basic results for VACES' operation. These papers provide performance-related measurements and some information on the chemical composition of the aerosol from VACES. Recent work by other researchers on VACES using aerosol mass spectrometers indicates that aqueous-phase fog processing and positive adsorption artifacts do occur. Independent evaluations that investigate the question of conservation of particle composition are necessary to help resolve these issues and establish a scientifically defensible position in the validation of VACES.

**OBJECTIVE:** This objective is to provide further tests to help determine the extent of possible artifacts from the use of VACES.

**DESCRIPTION:** Artifacts may be generated by the particle concentrator as the result of adsorption/absorption artifacts (both organic and inorganic), fast cloud chemistry (processing of inorganic and organic compounds), and kinetic growth limitations and/or coagulation of droplets for small particles in the saturator. Physical and chemical characteristics of the output aerosol from VACES need to be better characterized. Some aspects that need further exploration are:

- Whether gas-phase organic species in the input air influence the composition of the output aerosol from VACES.
- Whether the concentrator causes nitrate enrichment through a fog-processing cycle.
- The fate of particles under 30 nm, which exhibit a decrease in enrichment factor
- Possible chemical effects, such as aqueous phase sulfur chemistry in particles from the concentrator.
- The ability of the diffusion dryer to function properly over long periods of time.

**BENEFITS:** The ARB needs a system that can accurately generate concentrated exposures to real-time PM found in California. The effort by the USC team has been very impressive, and toxicology studies based on VACES are providing major new PM health effects information. Understanding of the relative toxicity of size, site, and seasonal differences in ambient PM is vital to the development of future regulations to protect the public health. From the ARB's experience in developing health-protective regulations, we are aware of the need to validate the scientific basis for our regulations. Therefore, the performance of VACES should be characterized to the greatest extent feasible.

**48) TITLE: Climate Change - Characterization of Black Carbon and Organic Carbon Air Pollution Emissions and Evaluation of Measurement Method**

**PROBLEM:** Black carbon (BC) or “soot”, desert dust, and some organic carbon (OC) species can absorb light and have a climate warming effect. It has been proposed that reductions of BC particles may slow the rate of global warming. However, BC is emitted simultaneously with OC, which has a net negative climate forcing. Hence, the net climatic effect of reducing emissions of fine particles is ambiguous until, at least, the relative amounts of BC and OC are known. For the purposes of climate change emissions inventories, BC is defined as the carbon component of particulate matter that absorbs light. However, this specific component of PM is difficult to measure. Methods that measure light absorption in particulate matter assume that BC is the only light absorbing component present; however, some components of OC may also be light-absorbing; in this case, inventories of BC and OC may have overlapping impacts.

**PREVIOUS WORK:** Emissions inventories of BC developed to date have focused on industrial, utility, and residential combustion sources. In the U.S., off-road and on-road diesel sources are the major BC sources. Gasoline vehicles represent a smaller, but non-negligible source of BC emissions. Most source-characterization studies do not measure BC, but rather so-called “elemental” carbon (EC). This type of measurement is widely used in air-quality and source-characterization applications.

**OBJECTIVE:** This project would compare and contrast results from laboratory test and an ambient air field study of particulate carbon testing/sampling using optical and filter-based sampling techniques. This project would also clarify the role of different combustion processes in determining emission rates of BC and OC to the atmosphere including the uncertainty inherent in these factors.

**DESCRIPTION:** This research study will be conducted in two phases: Phase I – measurement method evaluation and Phase II - determination of emission rates of BC and OC. Measurement method evaluation would involve a comparison of EC/OC fractions and a comparison of EC results versus BC results using currently accepted analytical methods during a laboratory test and an ambient air study. Previous “bottom-up” inventories of BC and OC have assigned emission factors based on fuel type and economic growth factor alone. Because emission rates are highly dependent on the actual process used to determine them, this research project will consider the effects of fuel type, combustion process type, emission control, and their prevalence on a regional basis, with special attention given to the residential and transportation sectors.

**BENEFITS:** This project will result in a quantitative understanding of the effect of different combustion sources and their particle emissions. Furthermore, unlike the benefits associated with reductions in greenhouse gas emissions, which take decades to fully realize, reductions in particulate matter emissions yield immediate improvements due to their short atmospheric lifetime. Therefore, efforts to better characterize and subsequently control particulate matter can have an immediate and potentially profound impact on addressing global warming.

**49) TITLE: Determination of Particulate Matter Emissions from On-road Tire and Brake Wear, and Asbestos Emissions from Use of Automotive Friction Products**

**PROBLEM:** The tire wear particulate matter (PM) emissions factor in ARB's emissions model was last updated several years ago. The elimination of bias-ply tires may have significantly altered the total PM emissions from these sources. In addition, there is an area of concern regarding automotive friction products (e.g., brakes, clutch facings, and some automatic transmission components). Many of these parts contain asbestos, a known carcinogen. Brake wear emissions accounted for approximately 23 percent of the total 2000 statewide on-road emissions of motor vehicle PM10, but associated asbestos emissions are currently unknown.

**PREVIOUS WORK:** Although several studies have been conducted on tire and brake wear emissions, little information is available on the effects of vehicle load and driving cycle. Also, the proportion of automotive brakes containing asbestos, as well as the compositional proportion of asbestos within the brake material, is unknown.

**OBJECTIVE:** The goal of this project is to improve emission rates for tire and brake wear, and determine the asbestos content of automotive friction products.

**DESCRIPTION:** A literature search will be performed to determine what test procedures and test data are available regarding the measurement and analysis of PM emissions from tire and brake lining wear. In addition, the contractor will conduct a literature review of the amount of asbestos contained in samples of each friction product such as brakes, clutch facings, and some automatic transmission components, and their frequency of use by vehicle class. A distinction will be made between original engine manufacturer and aftermarket parts. Brakes will be categorized by front or rear, and by material type (asbestos, metallic, etc.). If sufficient funds are available from other sponsors, tire and brake lining wear measurements will be conducted.

**BENEFITS:** The ARB will acquire useful information on the use of automotive emission products containing asbestos, and thereby determine the need for regulatory control in order to protect public health. Also, the ARB will obtain a better estimate of the PM10 inventory contribution from tire and brake wear emissions.

#### **50) TITLE: Collection and Analysis of Weekend/Weekday Activity Data in the 1997 Southern California Ozone Study Modeling Domain**

**PROBLEM:** Both the on- and off-road mobile source emissions inventory models purport to estimate ozone episodic inventories. However, the activity estimates contained in current models are based on either monthly or yearly averages. Ozone episodes in Southern California occur more often on weekends than during the week, but little is known regarding changes in activity that might contribute to these episodes.

**PREVIOUS WORK:** Analyses of weekday versus weekend episodes have been performed by Dr. Winer of UCLA and ARB staff. However, these studies have been limited to the analysis of ambient monitoring station data.

**OBJECTIVE:** To conduct a comprehensive study of the activity changes in the mobile source fleet from weekday to weekend, with emphasis on understanding the relationship between activity and air quality.

**DESCRIPTION:** This study will gather information on the variation in activity occurring in the on-road fleet on weekdays and weekends, such as the number of trips per day, miles per day, and speed of each trip. The off-road fleet will also be monitored to determine the influences of increased activity in such areas as lawn and garden and recreational vehicle usage. The temporal resolution for activity data collection is hourly. The desired modeling domain is the area that includes Ventura and Santa Barbara Counties to the north and San Diego County to the south.

**BENEFITS:** The performance of this study will allow emissions modelers to produce ozone episodic inventories that depict activity more realistically. This approach will improve cost effectiveness analyses of ozone abatement strategies and the estimated results from airshed models. This information will also be used to modify the on- and off-road models to reflect weekend and seasonal variations in activity.

## **51) TITLE: Analysis of Weekend Episodic Activity**

**PROBLEM:** Both the on- and off-road mobile source emission inventory models purport to estimate ozone episodic inventories. However, the activity estimates contained in the models are based on either monthly or yearly averages. It is widely known that ozone episodes occur more often on weekends than during the week, but little is known regarding changes in activity that might contribute to these episodes.

**PREVIOUS WORK:** Analyses of weekday vs. weekend episodes have been performed by Dr. Winer of UCLA. However, these studies have been limited to meteorological influences and the analysis of ambient monitoring station data.

**OBJECTIVE:** To conduct a comprehensive study of the activity changes in the mobile source fleet from weekday to weekend, with emphasis on understanding the relationship between activity and air quality.

**DESCRIPTION:** This study will gather information on the variation in activity occurring in the on-road fleet on weekdays and on the weekends such as the number of trips per day, miles per day and speed of each trip. The off-road fleet will also be monitored to determine the influences of increased activity in such areas as lawn and garden and recreational vehicle usage. This information will then be used to modify the on- and off-road models to reflect weekend and seasonal variations in activity.

**BENEFITS:** The performance of this study will allow emissions modelers to produce ozone episodic inventories that depict activity more realistically. This approach will improve cost effectiveness analyses of ozone abatement strategies and the estimated results from airshed models.

## **52) TITLE: Development of an Analytical Test System for Heavy-Duty Diesel Vehicle Inspection and Maintenance**

### **ABSTRACT**

The desire to establish a heavy-duty I&M program in the State of California is to support the California State Implementation Plan, measure M-17, "Further Emissions Reductions from Heavy-duty Engines." The thrust is to identify gross emitters, particularly high NO<sub>x</sub> emitters, and hence reduce their contribution to the emissions inventory, leading ultimately to improvements in air quality. Objectives of this study included identification of a suitable system that would both identify high emitters and realistically quantify emissions from in-service vehicles (System 1) and of a suitable system only for detection of gross emitters (System 2).

Link to full Report: <ftp://ftp.arb.ca.gov/carbis/research/apr/past/98-319.pdf>